Vega Launcher

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VEGA Integrated Project Team
ESA-ESRIN

Launchers "not just a vehicle"

Providing access to space

Enabler of space activities
Development of space applications sector
Unrestricted access to space for strategic purposes

Developing and safeguarding industrial capabilities

Launcher systems developed and produced by European industry
More than 50 industrialists involved in ESA Member States
Financing more than 3.8 billion € over 2005-2011

Promoting research and development

Solid technology base in all critical areas
(system, solid & liquid propulsion and stage & equipment)

European undertaking

12 Main Participating States
Enabling autonomous action in the space sector
European launch range located in French Guiana

ESA Programmes for a Family of Launchers

VEGA THE SMALL LAUNCHER FOR EUROPE

history | industry | ESA IPT | synergy

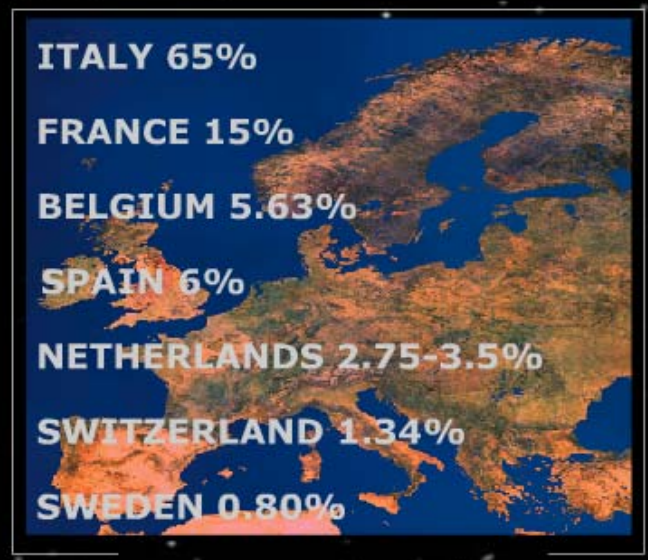
The organisation

Historical background

December 2000:
Approval of the two Development Programmes for Vega, launch vehicle and P80-FW.

Approval of the Launcher Development Programme with a financial envelop of **335M Euros.**

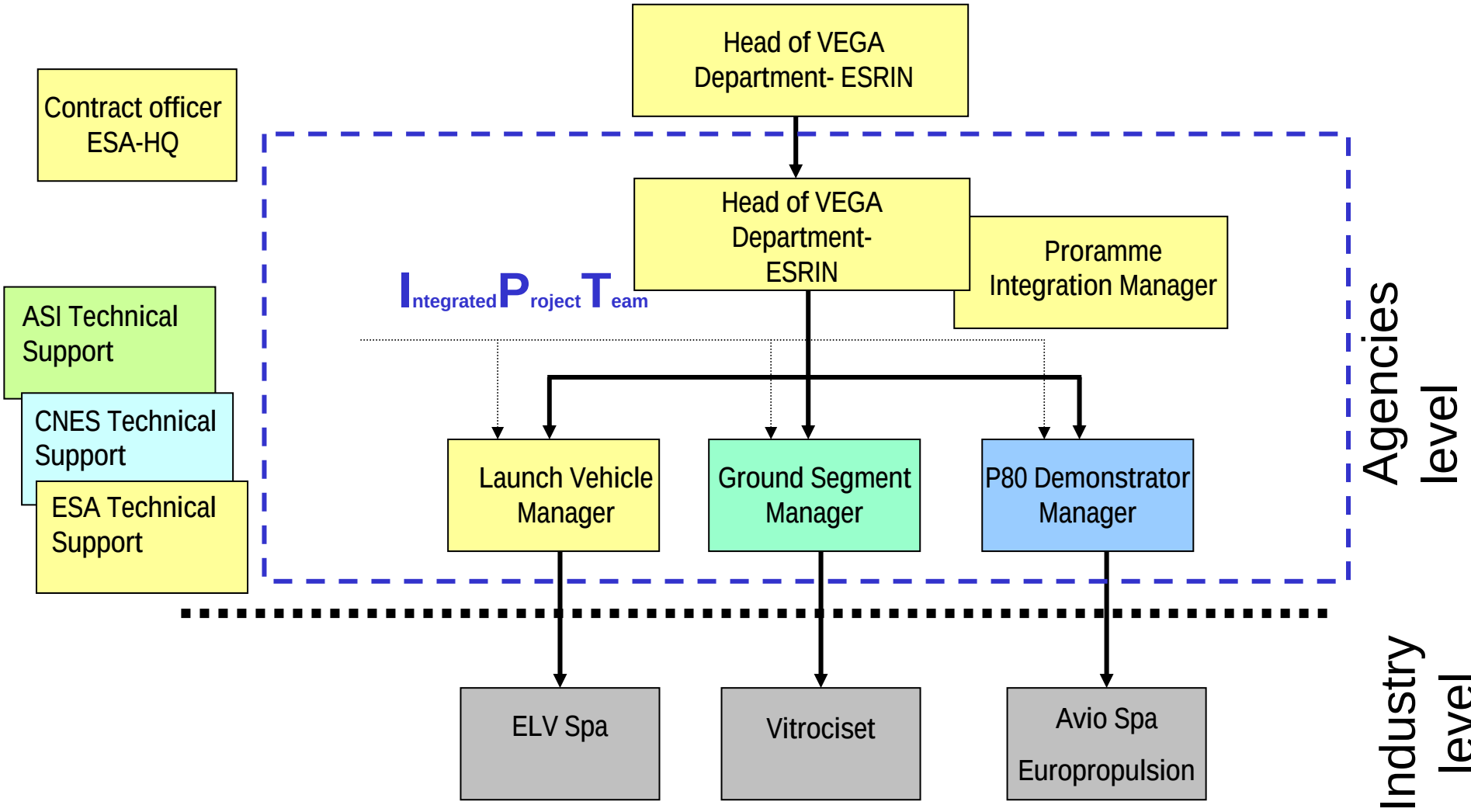
Seven participating countries:
Belgium, France, Italy, the Netherlands, Spain, Sweden, Switzerland.



map | home | credits

VEGA
Programme Management and Industrial Organisation

VEGA Programme Management



VEGA industrial organisation

The development and production of the launch system is contracted to a prime

VEGA Launch Vehicle Programme

- **ELV S.p.A. (70% Avio Spa and 30% ASI),** -located in Colleferro, Italy- is the prime contractor for the launcher development and production.

P80 Demonstrator Programme

- **Avio S.p.A.** is prime contractor for the P80 with a programme management delegation to **Europropulsion**, France.

Ground Segment

- **VITROCISET** is prime contractor of the Ground Segment.

VEGA industrial partners

VEGA Launch Vehicle Programme

- CASA, CRISA, INTA, SENER, GTD (E)
- AVIO, Galileo, OCI, Vitrociset, Datamat (I)
- SABCA (B)
- Contraves (CH)
- Dutch Space (Fokker), STORK-SPE, TNO (NL)
- SAAB (S)
- EADS, Arianespace, Thales, Pyroalliance, ONERA, SAFT (F)

P80 Demonstrator Programme

- AVIO (I), REGULUS (F), SNECMA SPS (F), SABCA (B) and STORK-SPE (NL)

Ground Segment

- Carlo Gavazzi Space, Alenia (Laben), Peyrani, OCI, Gruppo Rossi, CERASI, Dataspazio, Siram (I)
- Thales, Nofrayane (F)
- Cegelec, Axima (B)
- GTD (E)

VEGA Launch Vehicle

VEGA at a glance

Reference lift capability

The Reference Performance of the VEGA launch vehicle launched from Kourou is:

1 500 kg at 700 km in circular polar orbit

(Mass defined above the launcher / payload interface)

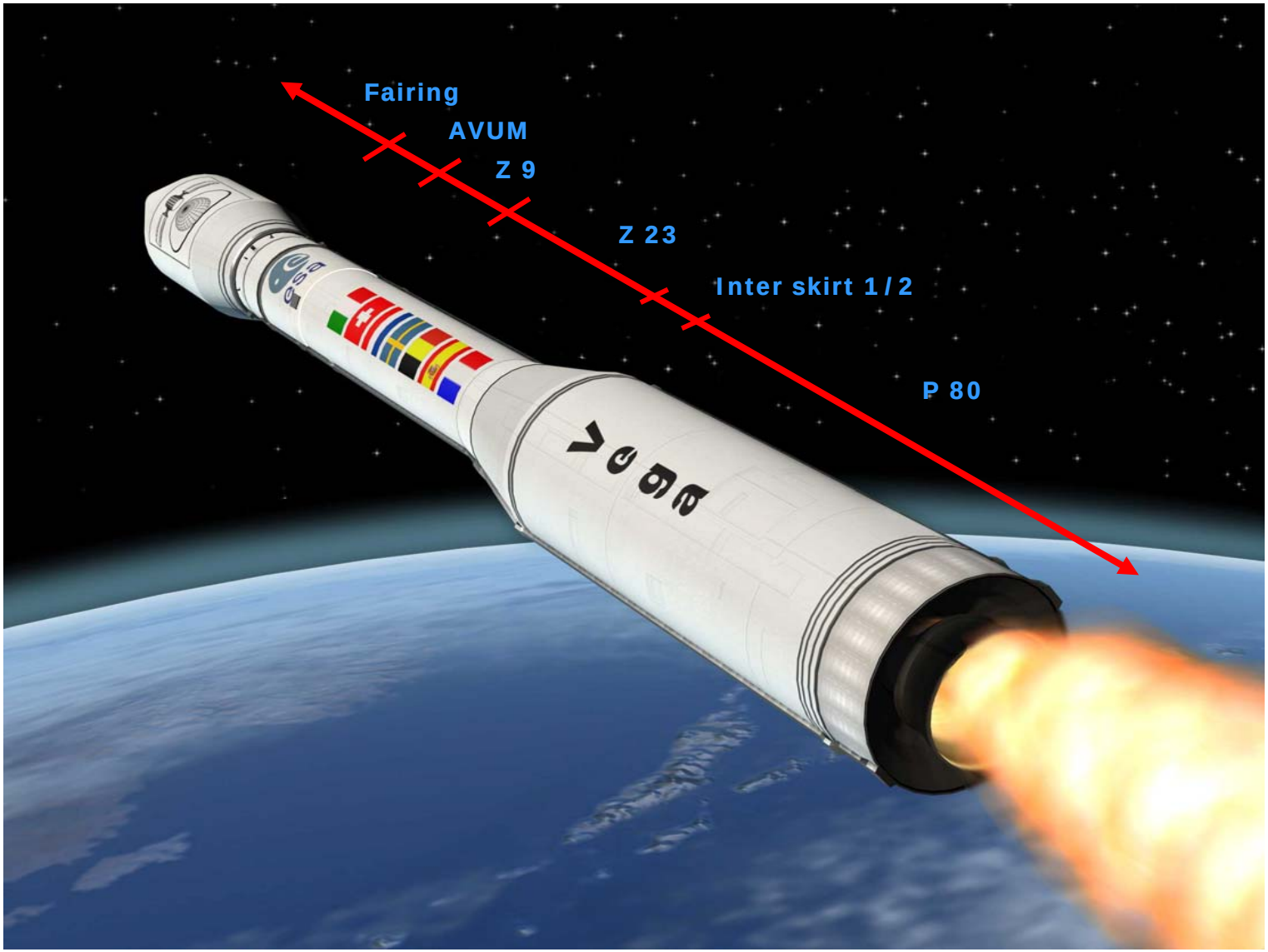
Standard Injection Accuracy

Standard (1 σ) VEGA injection accuracy are:

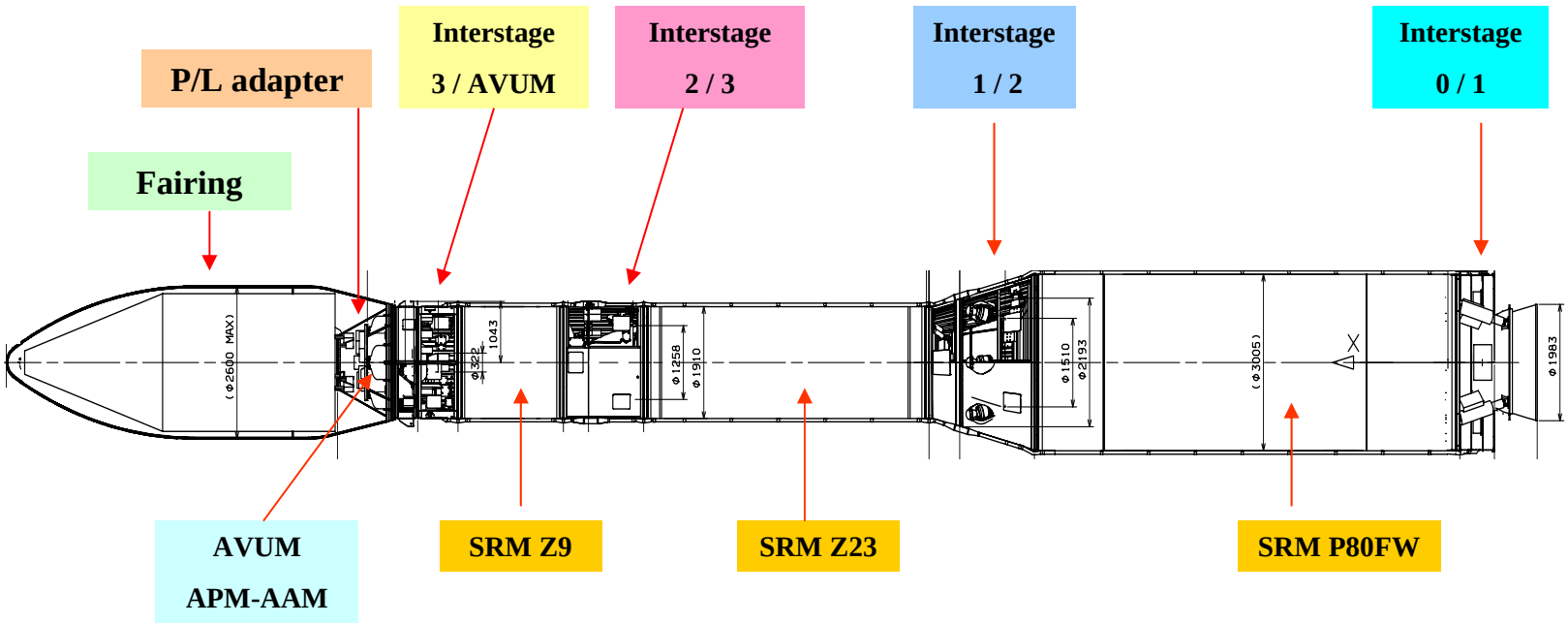
- **Altitude: 5 km**
- **Inclination: 0.05°**
- **Ascending node: 0.1°**

Restartable upper stage able to perform multiple mission profile

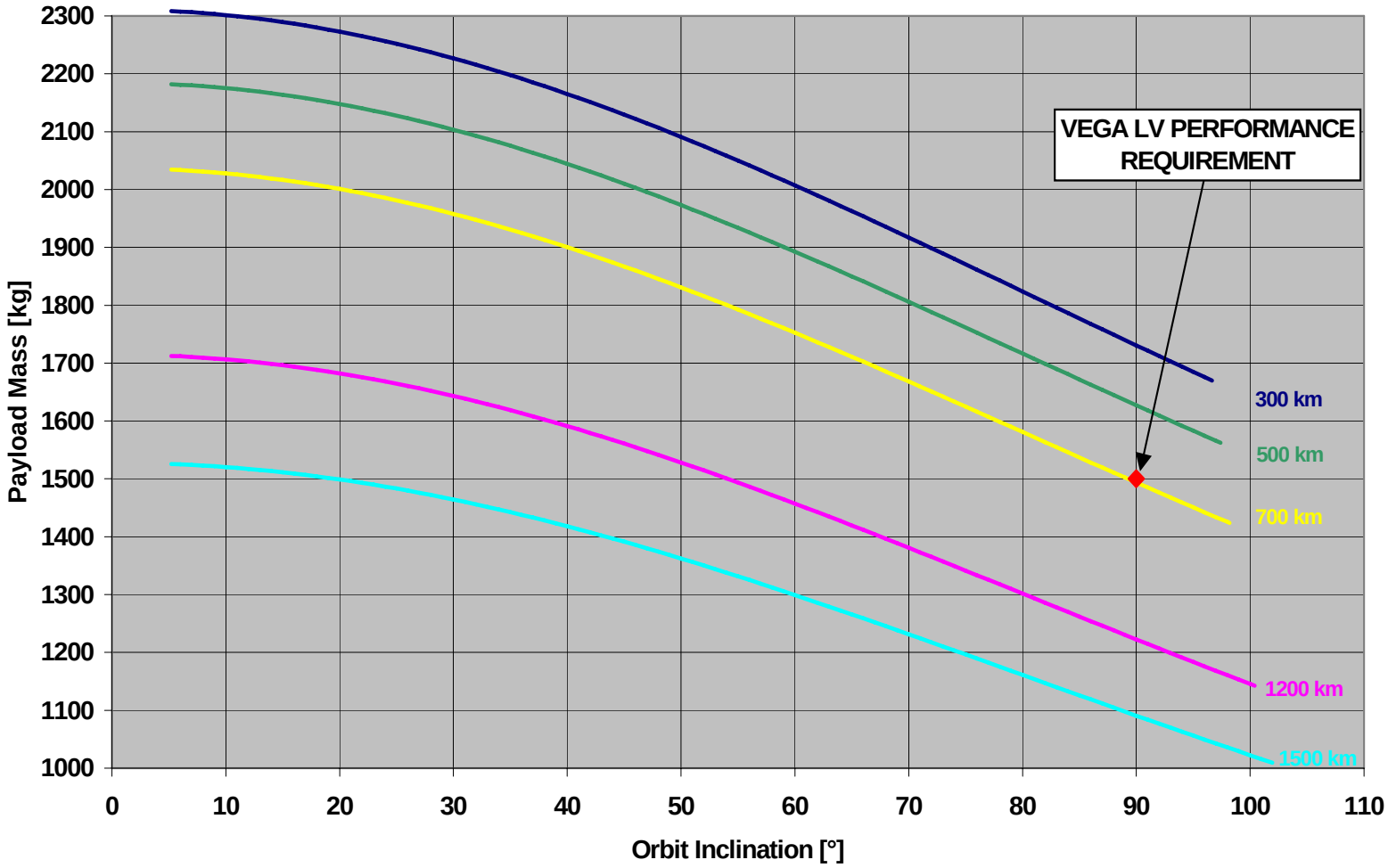
- **From equatorial to polar & SSO orbit (5.2° - 102°)**
- **From 300 km to 1 500 km altitude**
- **From 300 kg to 2 500 kg**


Fairing
AVUM
Z 9
Z 23
Inter skirt 1/2
P 80

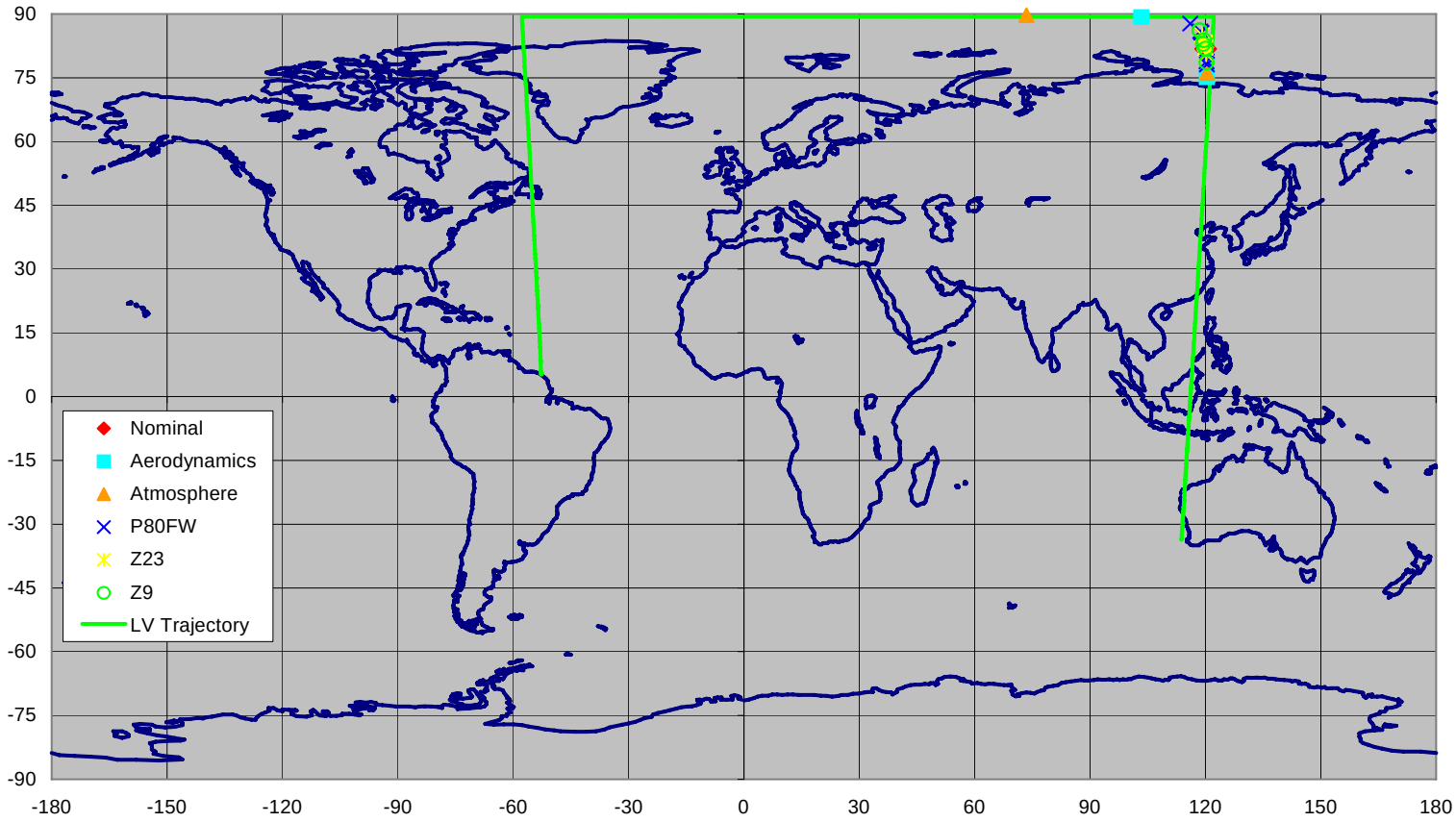
VEGA Launch Vehicle Configuration



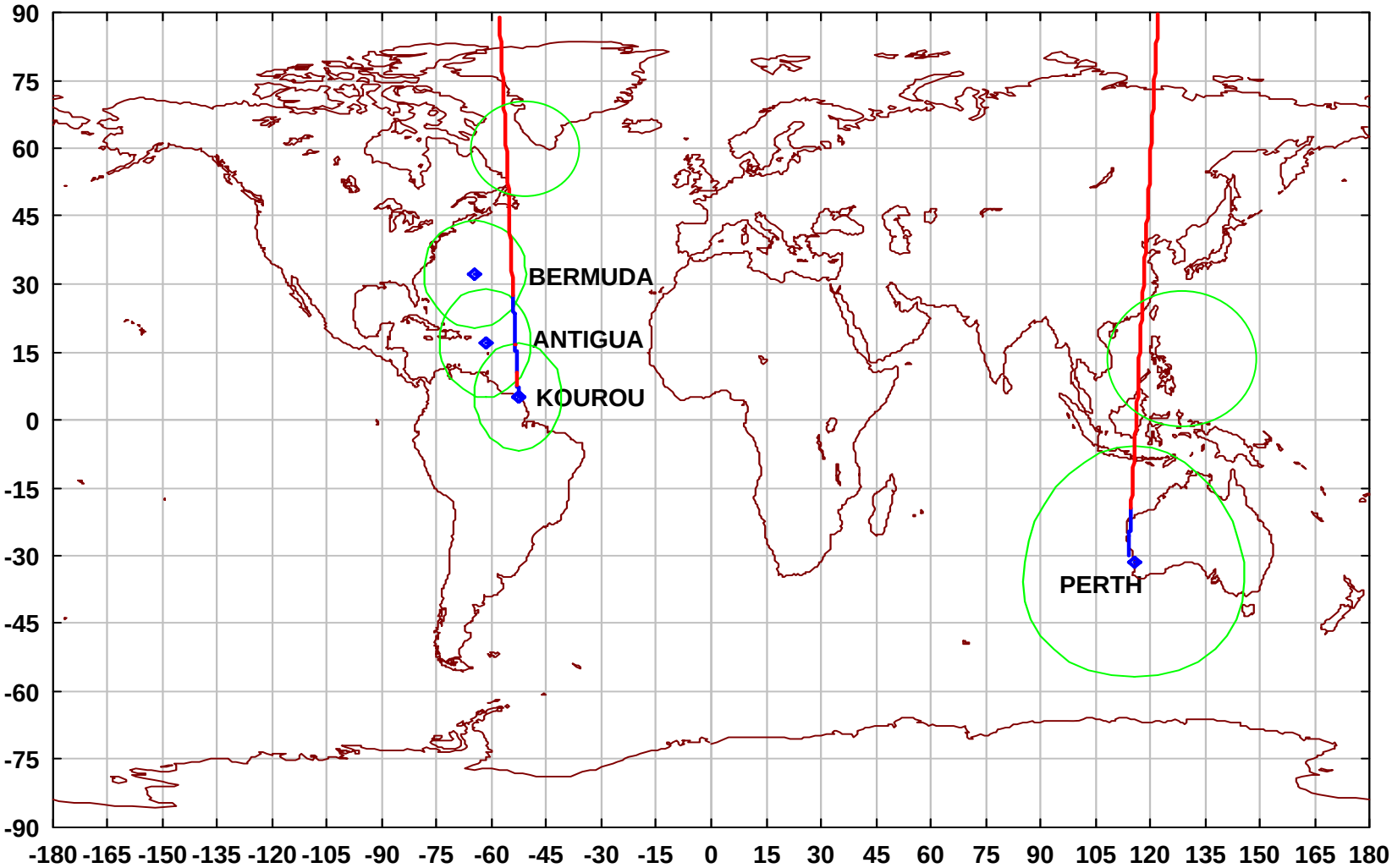
VEGA Performance Map



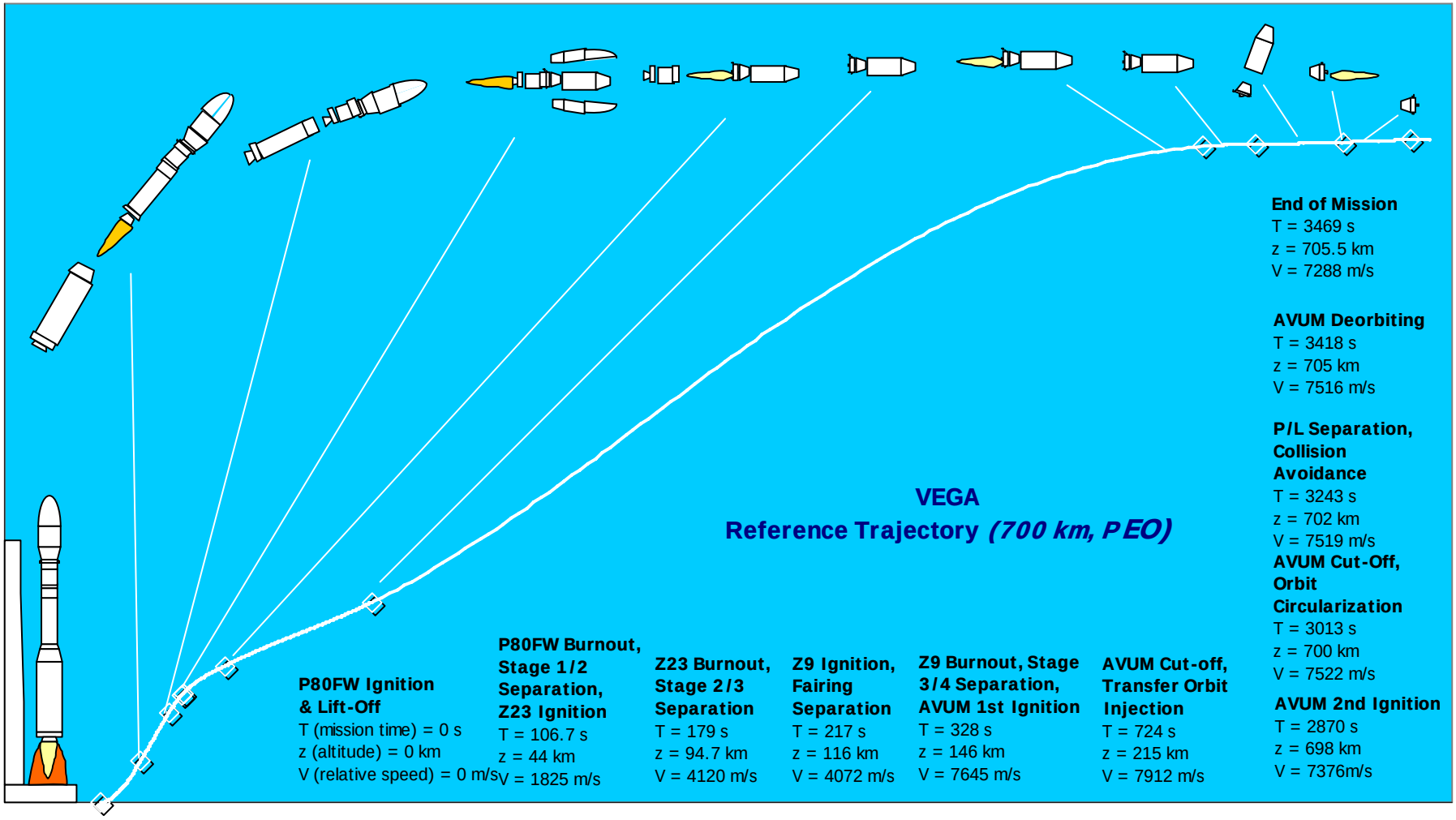
VEGA TRAJECTORIES -3rd STAGE RE-ENTRY
(700 km, PEO trajectory - 99.7% probability level)



Tracking stations

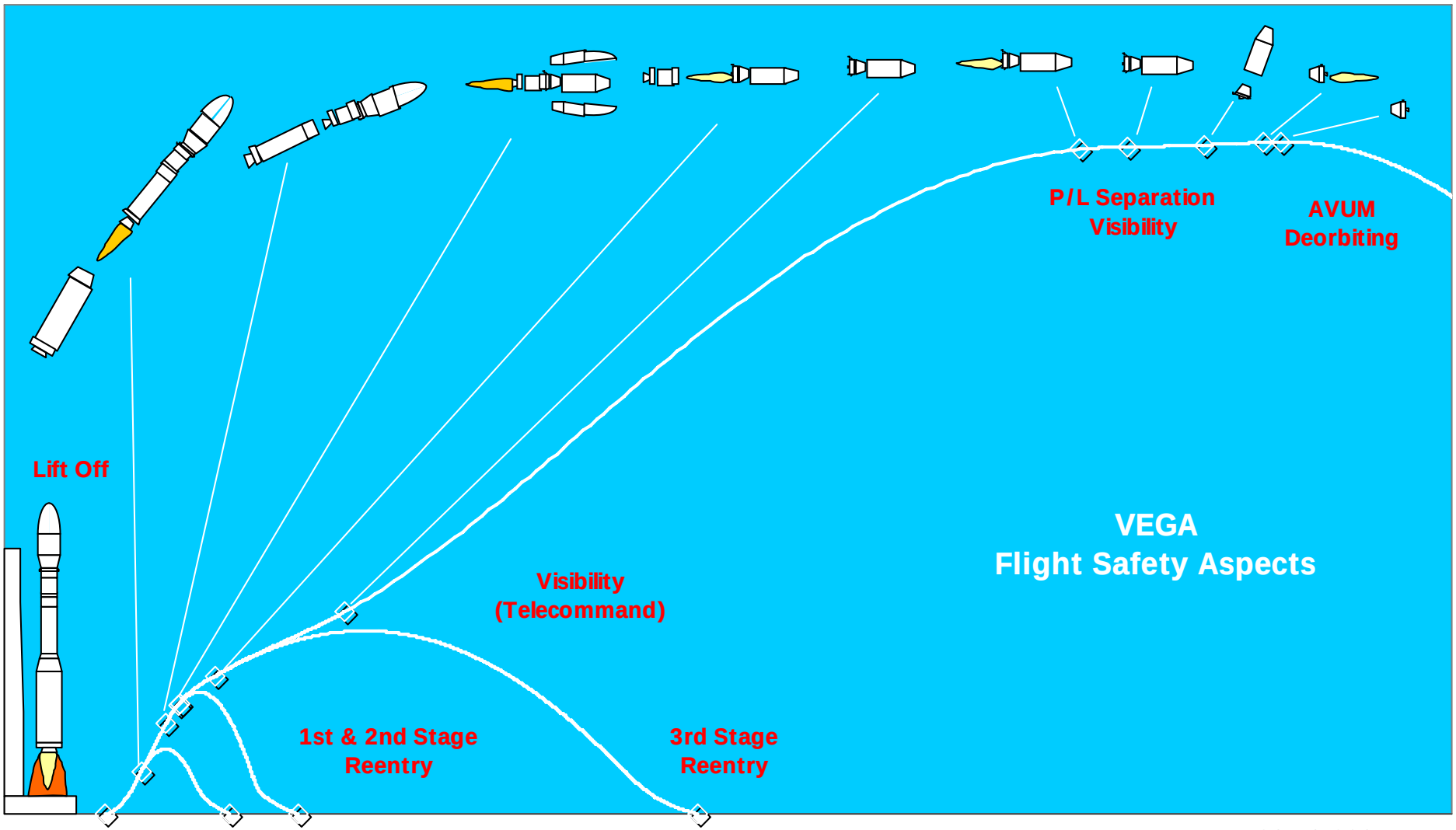


Launch Sequence of main events



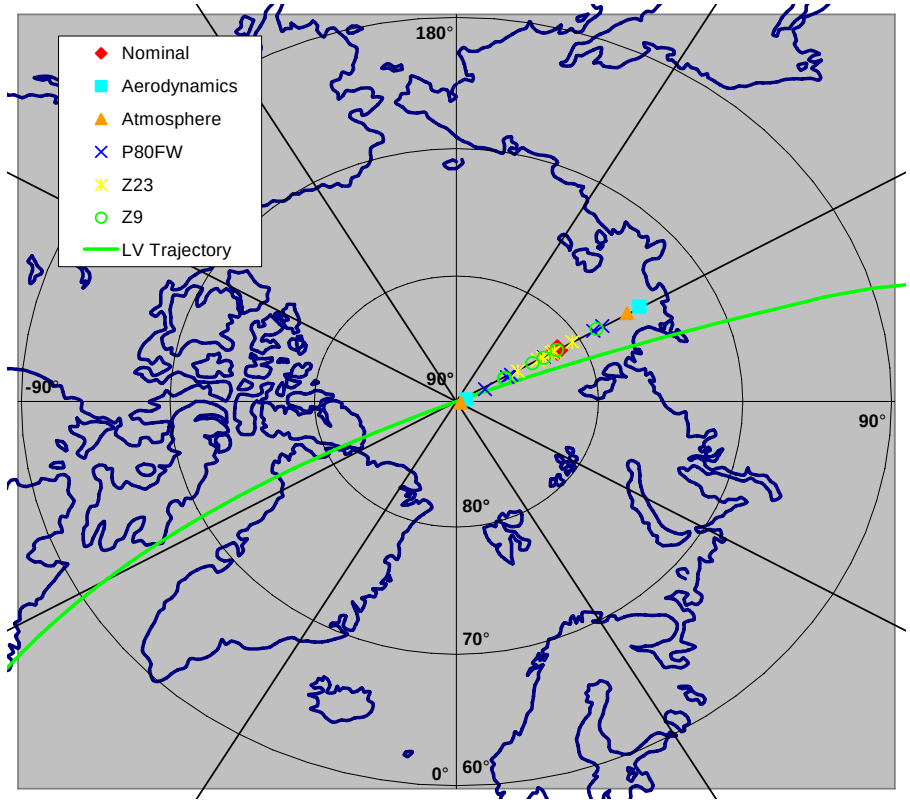
(Altitude vs. time)

Stages re-entry

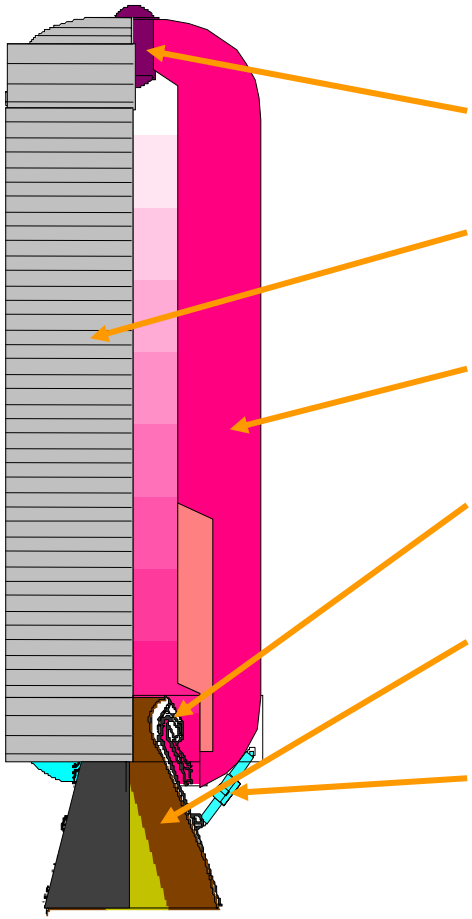


(Altitude vs. time)

VEGA TRAJECTORIES -3rd STAGE RE-ENTRY (700 km, PEO trajectory - 99.7% probability level)



VEGA SRM(s) – Overall description



Consumable Igniter

Filament wound composite case and skirts

Propellant grain (finocyl shaped configuration)

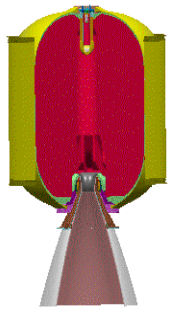
Low-torque flexible joint

Nozzle

TVC system

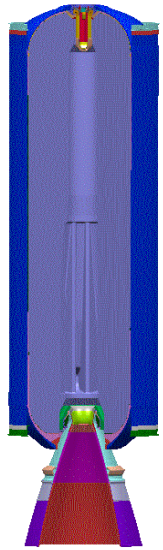
The solid propellant stages

Zefiro 9 FW



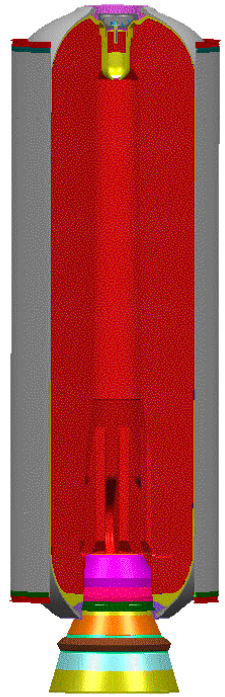
L: 4.12 m	∅ : 1.925 m
Combustion time:	117 s
Thrust (vacuum):	280 kN
Max pressure:	67 bar
Propellant mass:	10 115 kg
Inert mass:	833 kg
Vacuum specific impulse:	294 s
Nozzle expansion ratio:	56
Nozzle deflection angle:	+ / - 6°

Zefiro 23 FW



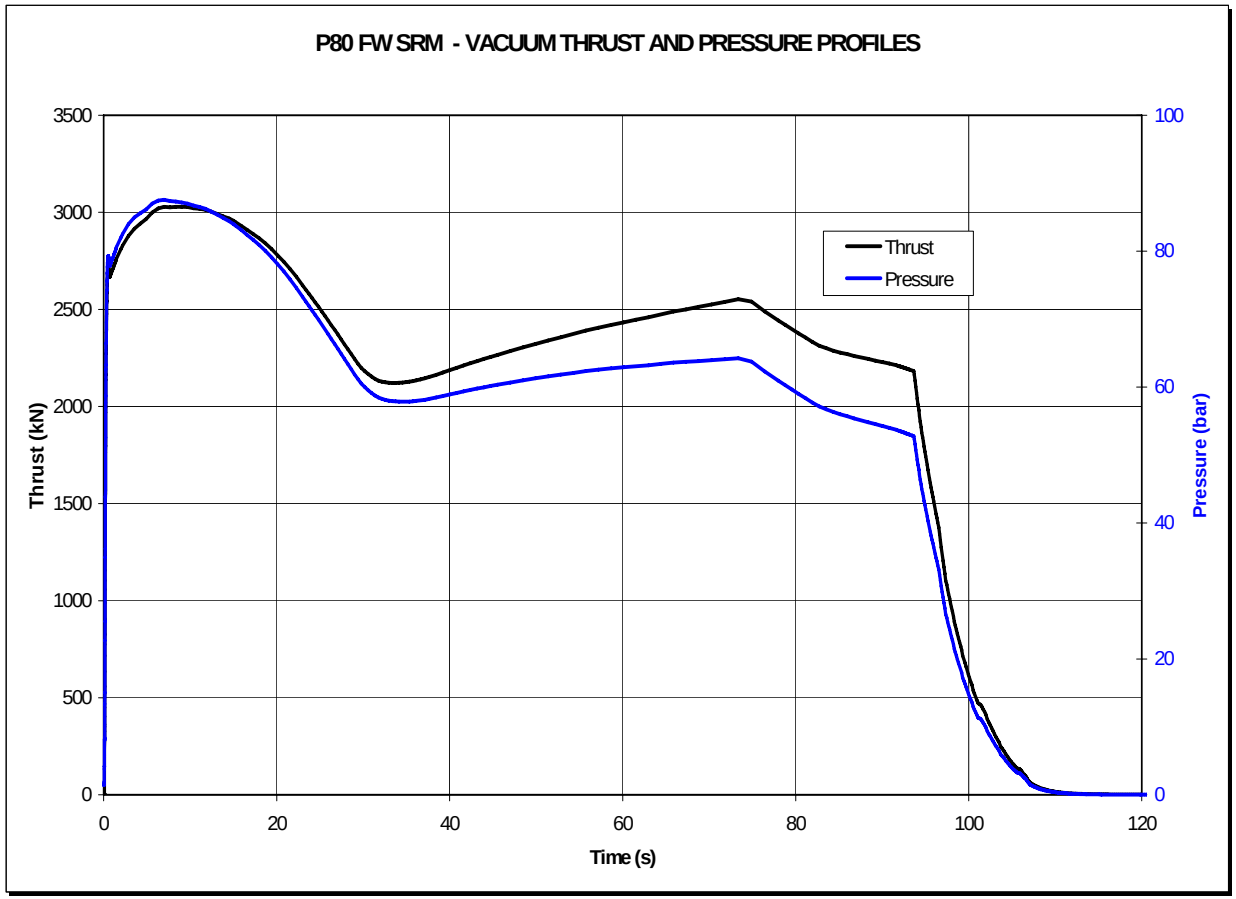
L: 8.9 m	∅ : 1.925 m
Combustion time:	71 s
Thrust (vacuum):	1200 kN
Max pressure:	95 bar
Propellant mass:	23900 kg
Inert mass:	1877 kg
Vacuum specific impulse:	289 s
Nozzle expansion ratio:	25
Nozzle deflection angle:	+ / - 6.5°

P80 FW



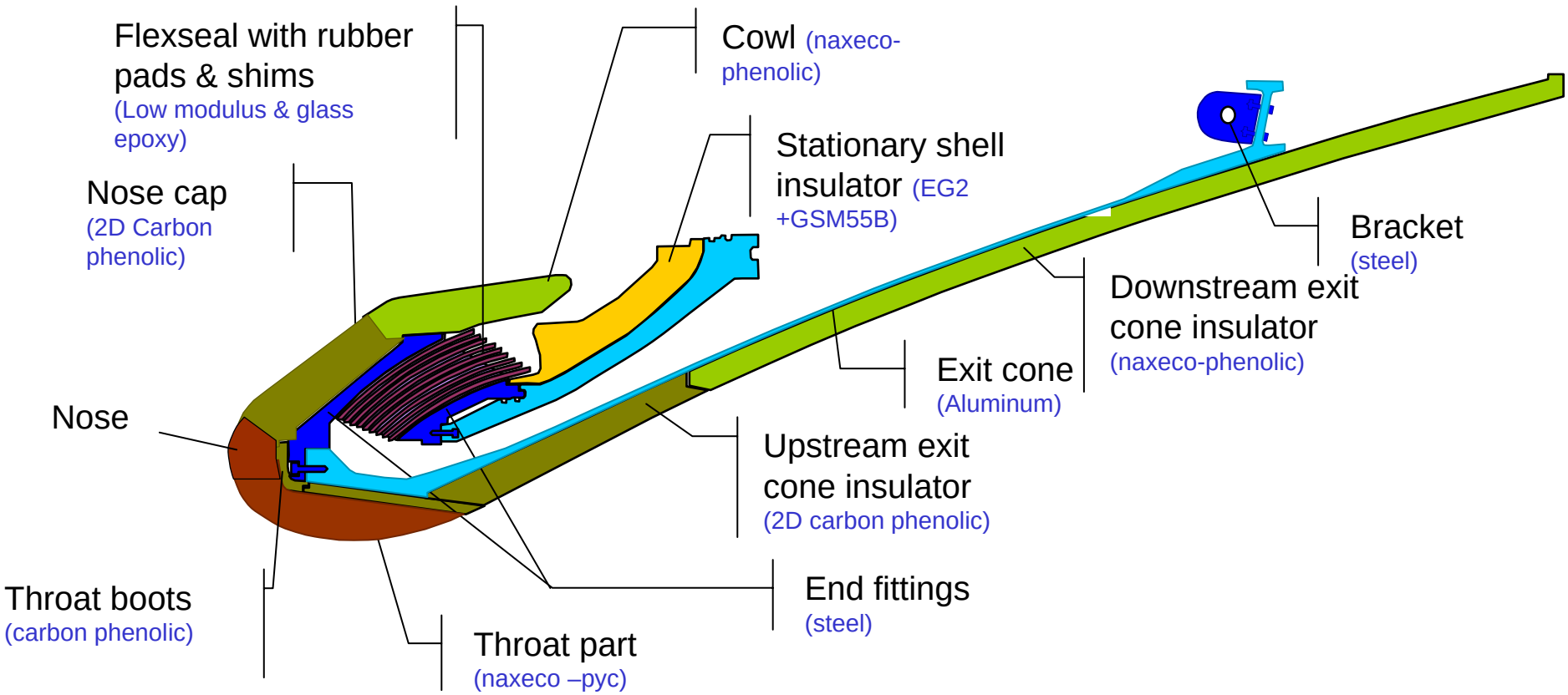
L: 10.5 m	∅ : 3.0 m
Combustion time:	107 s
Thrust (vacuum):	2980 kN
Max pressure:	95 bar
Propellant mass:	88383 kg
Inert mass:	7408 kg
Vacuum specific impulse:	279.5 s
Nozzle expansion ratio:	16
Nozzle deflection angle:	+ / - 6.5°

P80 SRM characteristics and performances

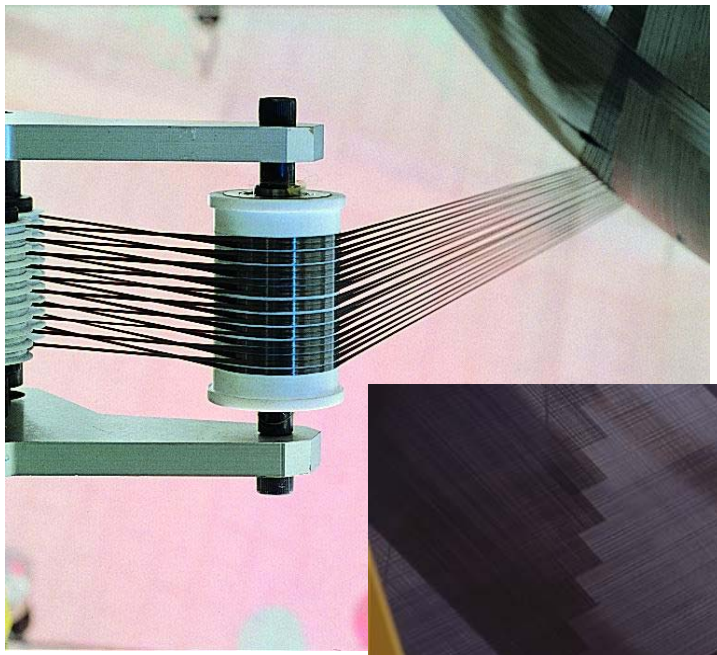


P80	
Overall Lenght [mm]	10557
Outer Diameter [mm]	3003
Propellant Mass [Kg]	88385
Inert Mass [Kg]	7408
Burn time [s]	106.7
Vacuum specific impulse [s]	279.5
Max Vacuum Thrust [KN]	3050
MEOP [bar]	95
Nozzle expansion ratio	16
Nozzle deflection angle (°)	+/- 6.5

P80 NOZZLE : Reference Design



SRM Case

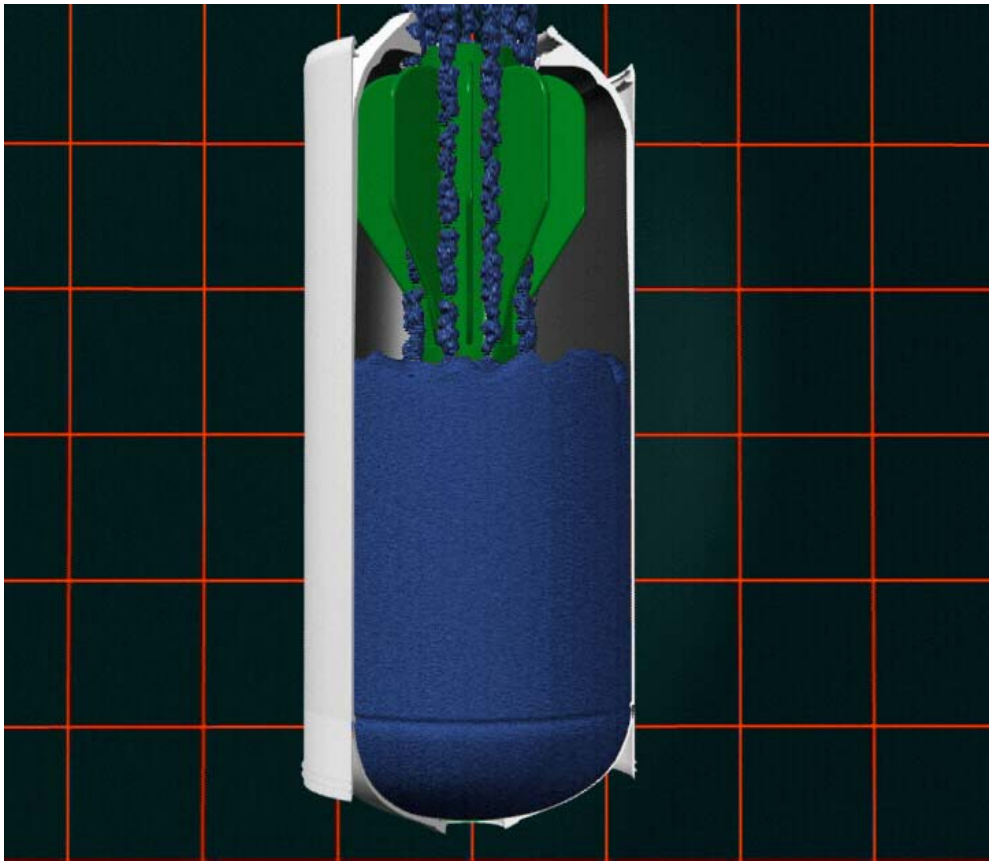


Carbon/epoxy wound case

- **3m diameter for P80**
- **2m diameter for Z23 and Z9**

P80, Z23 and Z9 cases are manufactured in Avio facilities (Colleferro)

SRM Propellant



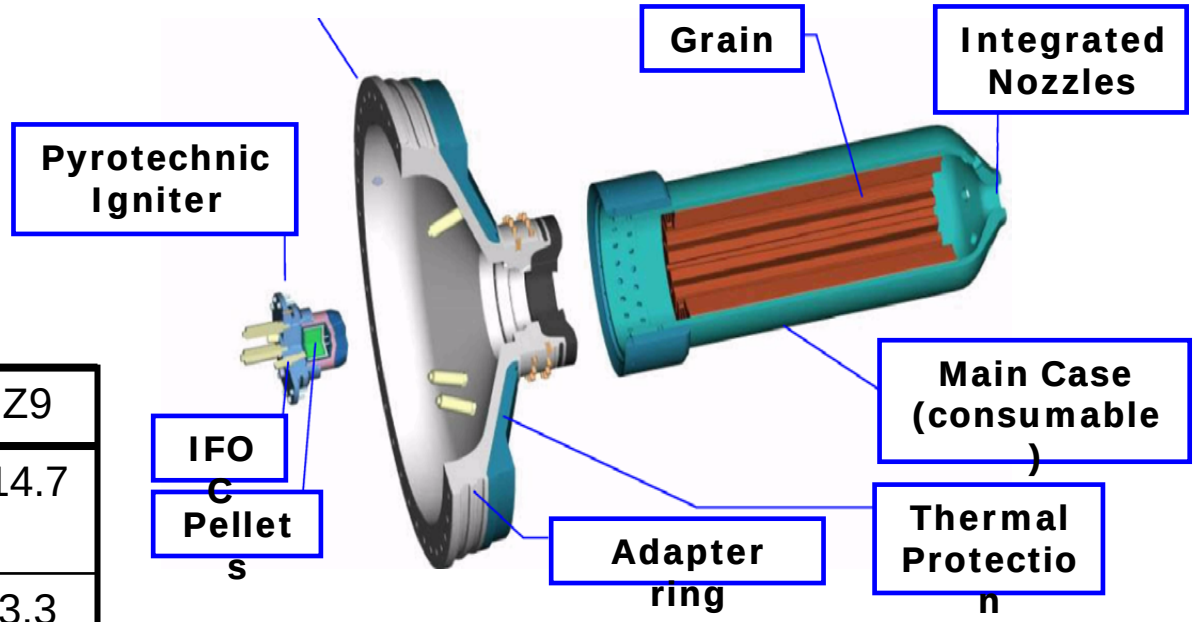
HTPB 1912 propergol (the same for all 3 SRMs but with a different combustion velocity).

Casting operation

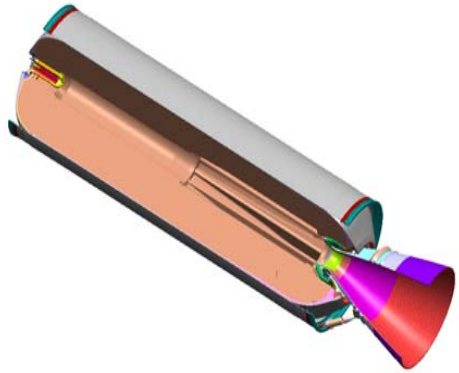
- **in Avio facilities for Z23 and Z9 (Colleferro),**
- **in Guyana for P80.**

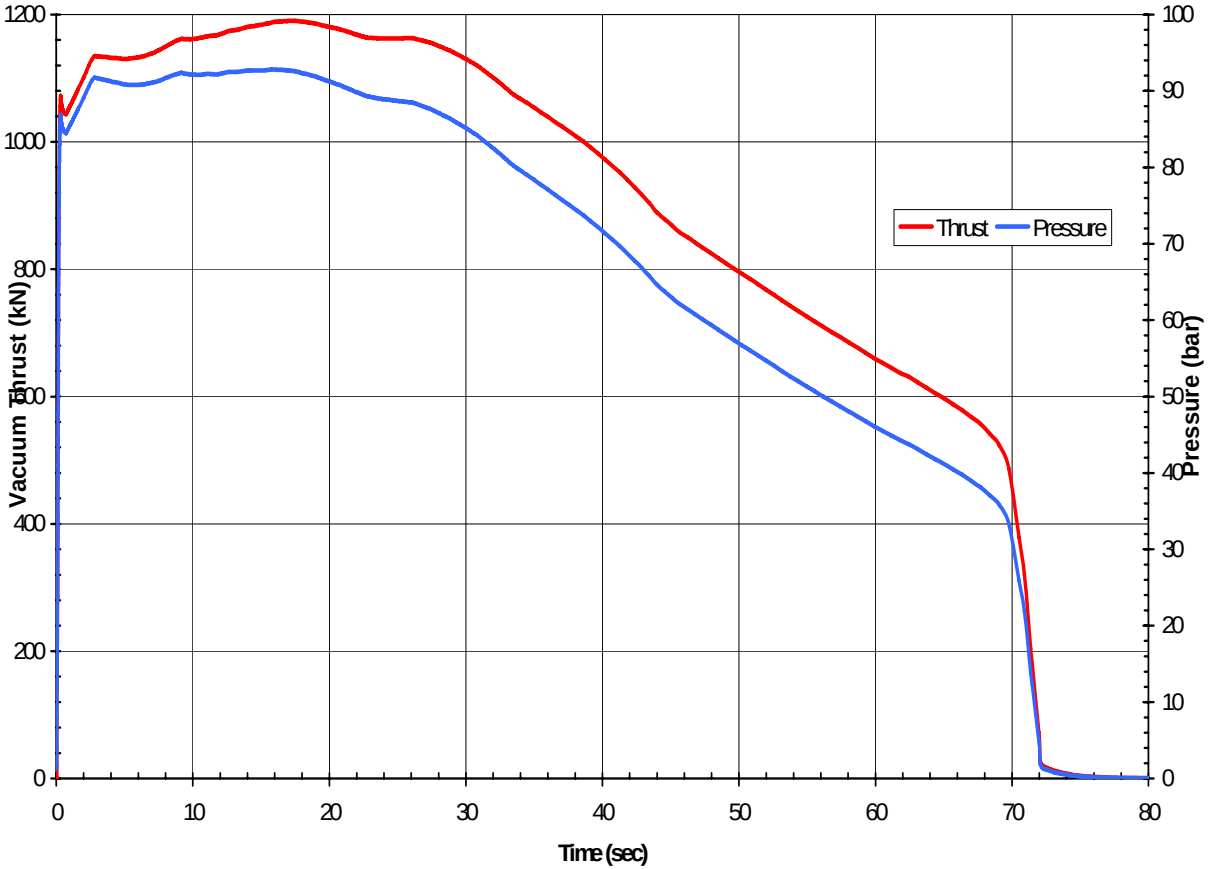
SRM Igniters

	P80	Z23	Z9
Total mass (Kg)	130	34.3	14.7
Grain mass (Kg)	22	9.4	3.3
Thermal energy (10^6 J)	93.4	42	15.1
Delay (s)	0.34	0.23	0.18



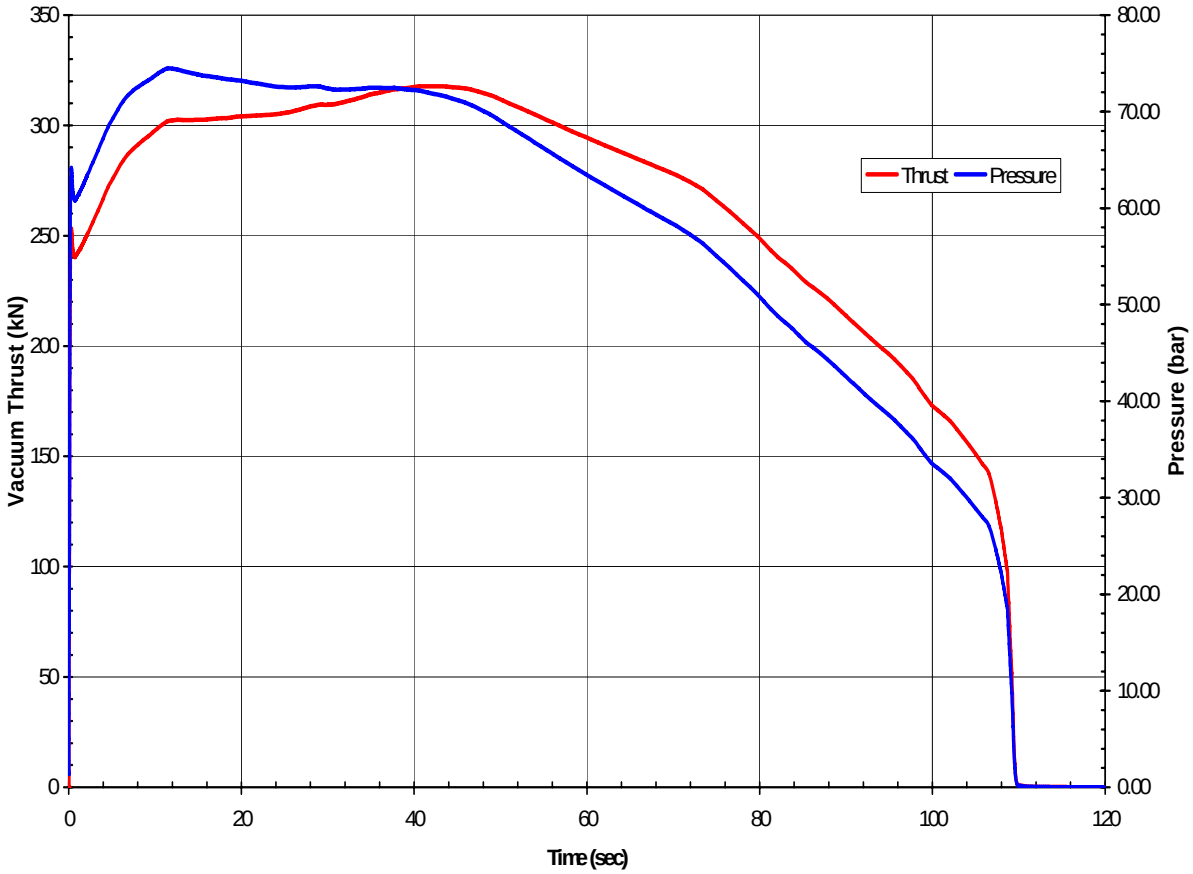
Zefiro 23 characteristics & performances

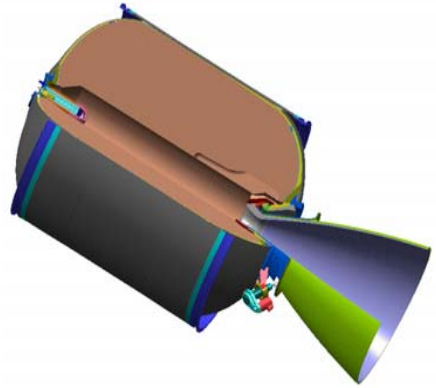




ZEFIRO 23	
Overall Lenght [mm]	7590
Outer Diameter [mm]	1905
Propellant Mass [Kg]	23900
Inert Mass [Kg]	1860
Burn time [s]	72
Vacuum specific impulse [s]	288
Max Vacuum Thrust [KN]	1200
MEOP [bar]	106
Nozzle expansion ratio	25
Nozzle deflection angle (°)	+/- 6.5

Zefiro 9 characteristics and performances



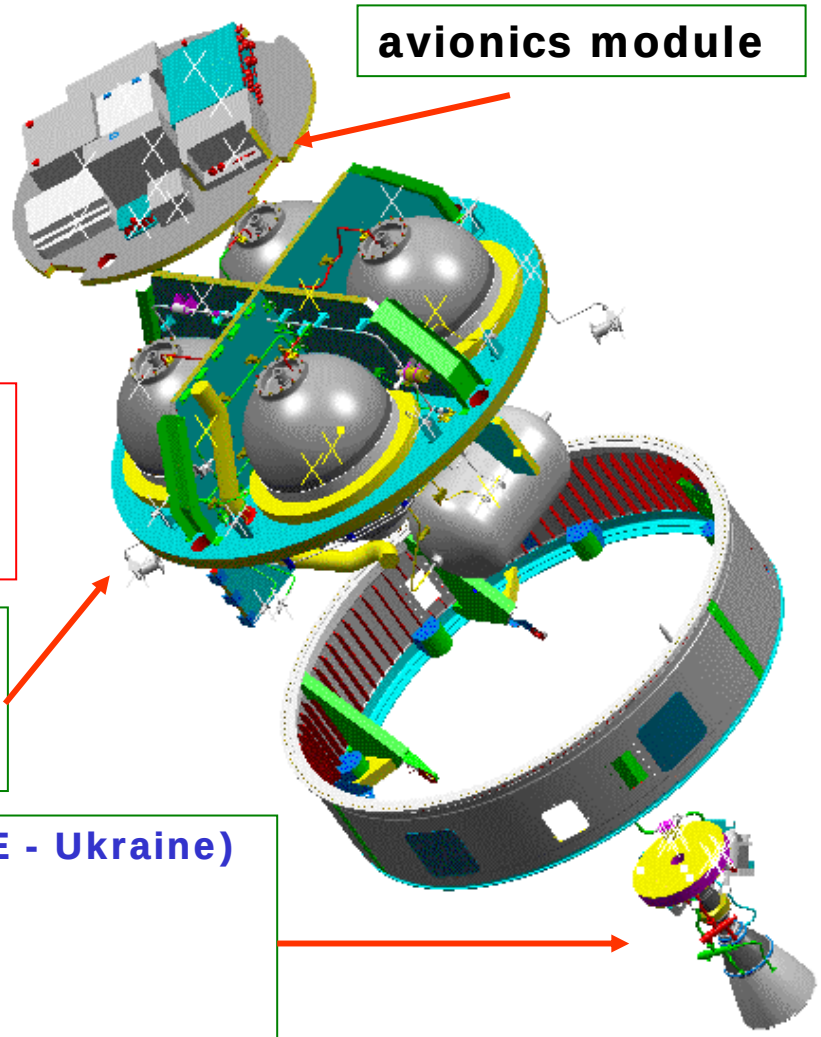


ZEFIRO 9	
Overall Lenght [mm]	3860
Outer Diameter [mm]	1905
Propellant Mass [Kg]	10115
Inert Mass [Kg]	835
Burn time [s]	110
Vacuum specific impulse [s]	295
Max Vacuum Thrust [KN]	330
MEOP [bar]	83
Nozzle expansion ratio	56
Nozzle deflection angle (°)	+/- 6°

AVUM

Helium pressurised tanks (GHe): 88 litres @ 310 bar
Propellant tanks
UDMH: 2 x 142 litres
NTO: 2 x 142 litres
Max pressure: 36 bars

RACS: 2 x 3 thrusters
Thrust: 200 N (each)
NH4 tank: 15 litres @ 26 bar



Main engine: RD-869 (YUZHNOYE - Ukraine)
- **Thrust: 2450 N**
- **Specific impulse: 315.5 s**
- **Restartable: 5 times**
- **Gimbal displacement: +/- 10°**

Zefiro 9

1st Development firing test : Dec. 2005
2nd Qualification Firing test : Nov. 2008
Qualification Firing test: Feb. 2009

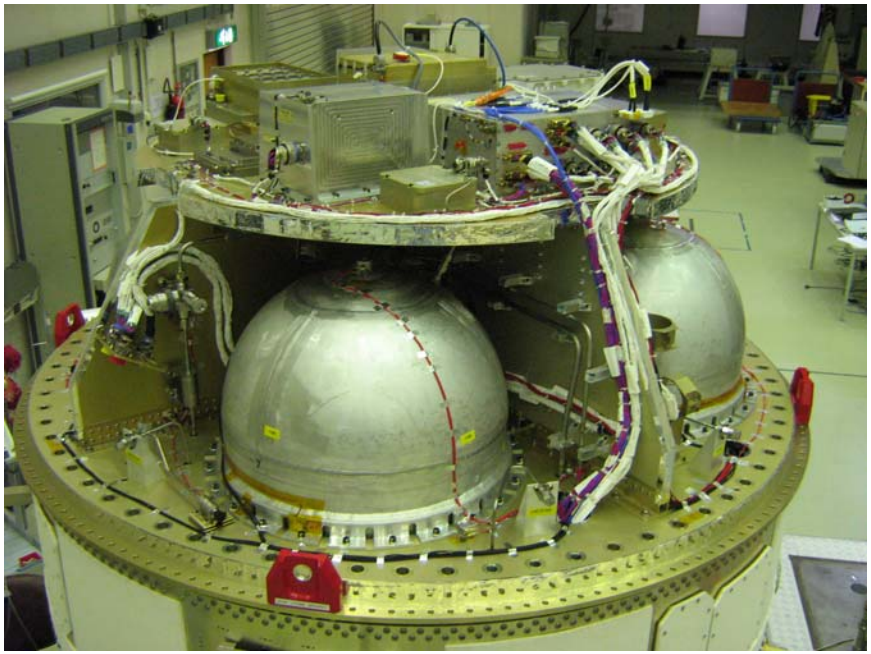
Development firing test : June 2006
Qualification Firing test : Sept. 2008

Zefiro 23 Vega 20/11/2008

Development firing test : Nov 2006
Qualification Firing test : May 2007

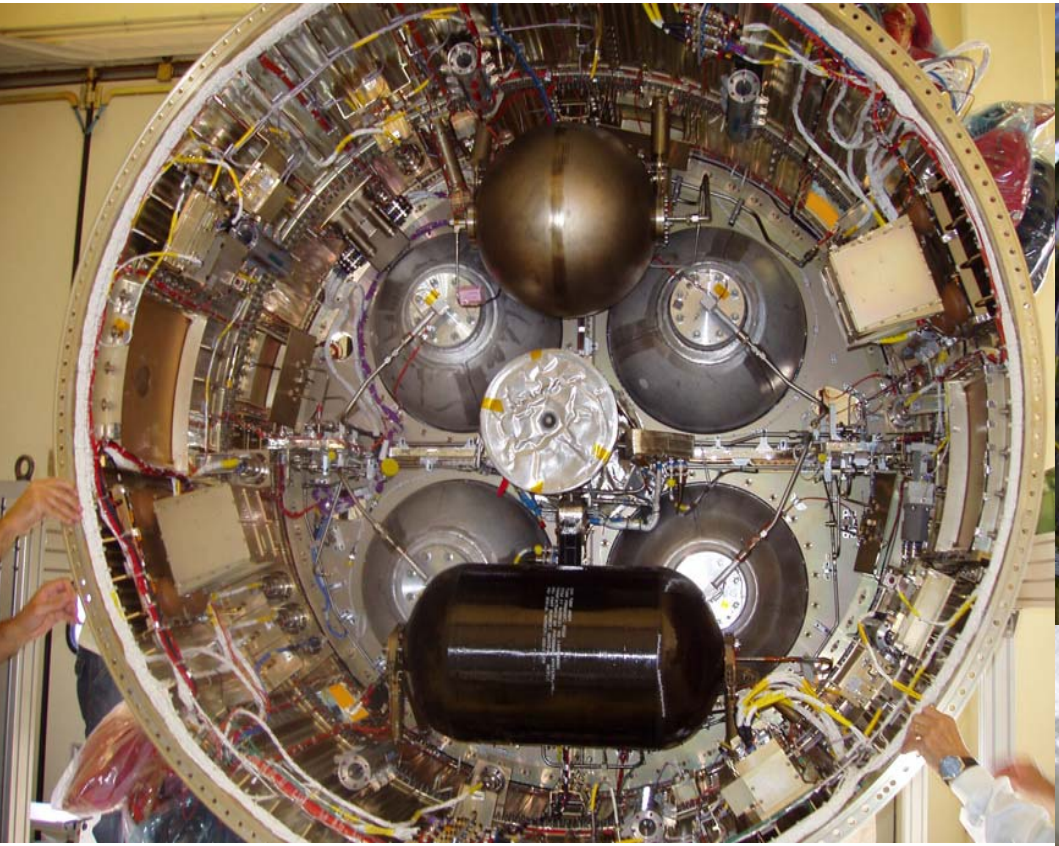
P80

The bi-liquid upper module, AVUM finishes of the primary injection and gives flexibility to achieve any orbit.



The **AVUM** provides roll control during the boost phases and three-axis control during ballistic phases before payload separation.

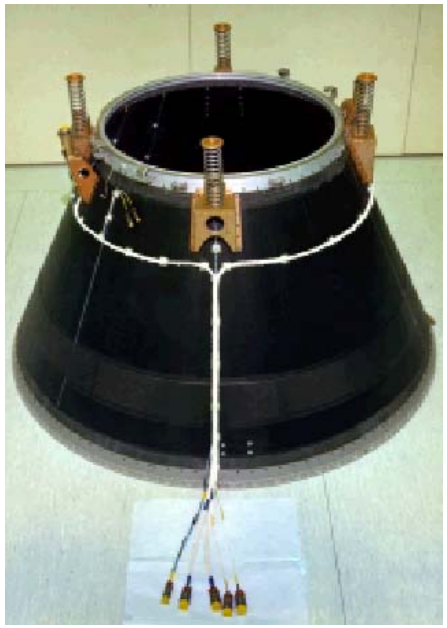
AVUM

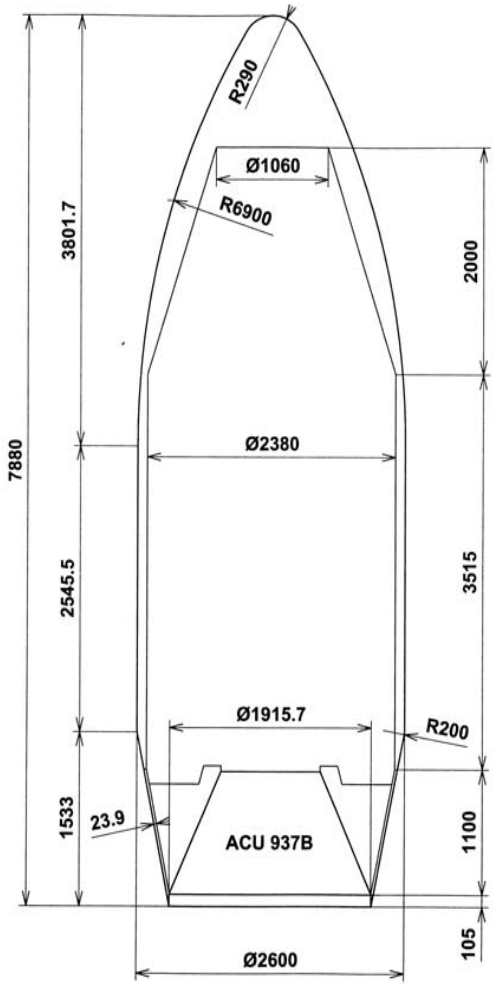


MEA Development firing test : 15-11-2005
MEA Qualification Firing test : Sept 2006
Stage firing tests (UCFIRE): Apr.-May 2007

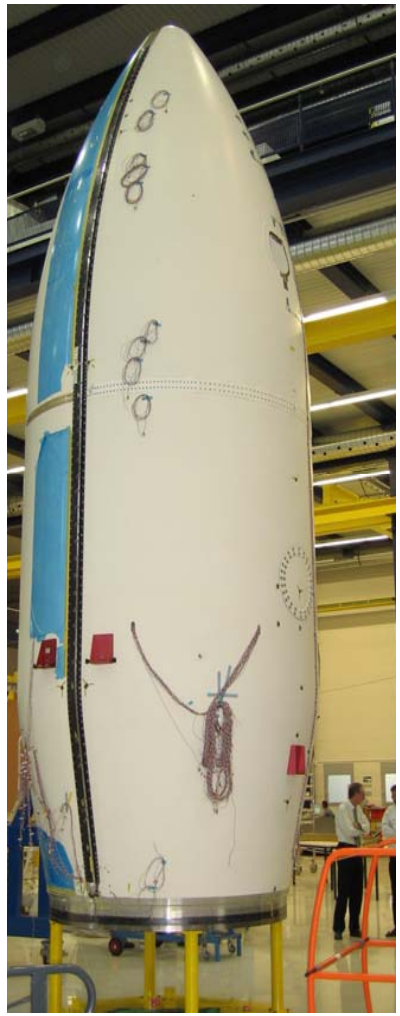
AVUM

Fairing + ACU 937B adaptor





VEGA USABLE VOLUME



SRMs: Requirements, Definition and Justification

SRMs: Requirements, Definition and Justification

Launcher Specifications

This specification defines the requirements and associated constraints concerning the performance, design, qualification and use of the Vega Launch Vehicle (LV) system. This specification shall be used as the basis for the elaboration of the projects, specifications of development and qualification work concerning all the hardware that constitute the Vega LV system.

SRM Functional Specifications

Reports the needs and constraints at which the Zefiro 9 Third Stage SRM must comply with during its non-operational and operational mission.
This specification is according with the high level needs reported in the ***Launch System Specification***.

SRM Technical Specifications

This Specification establishes the requirements in terms of: design; performance; interfaces; development; qualification; test; production; integration of the Zefiro 9 Solid Rocket Motor for the Third Stage of VEGA Launch Vehicle. It defines and implements all characteristics and performance required for the ZEFIRO 9 SRM in answer to the ***Functional Specification***

SRM Design Justification

The aim of the document is to furnish the technical justification of the Zefiro 9 SRM motor, as far as the requirements of design, propulsive performance and interfaces contained in the ***Technical Specification***.

[Requirement Z9 ST-05]

ZEFIRO 9 **SRM NON OPERATIONAL Phases.**

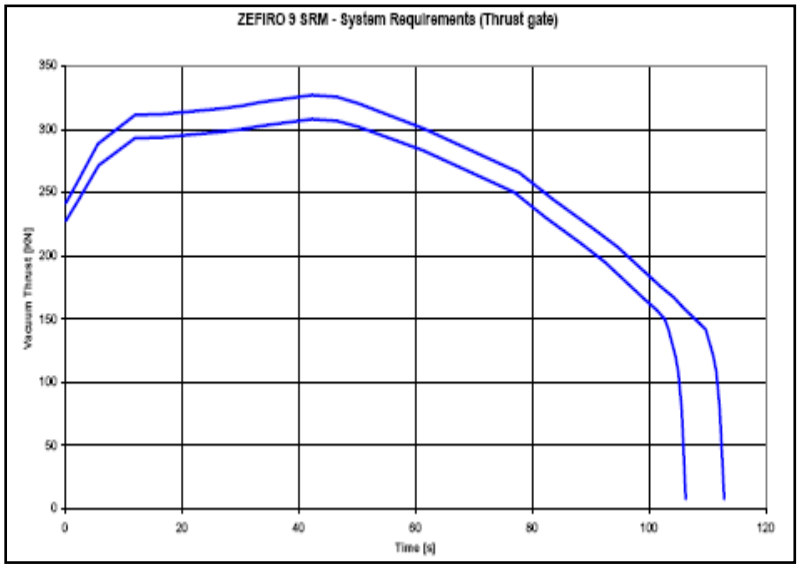
- Motor integration
- Motor acceptance
- Motor/stage handling
- Motor/stage storage in Europe
- Stage equipment integration
- Stage acceptance
- Stage transportation from production site in Europe to LV integration site in Guyana
- (BIV)
- Stage storage in Guyana
- LV lower assembly integration and test at BIV
- LV upper assembly integration and test at BIV
- LV taxiing to the launch pad
- Stand by on the launch pad

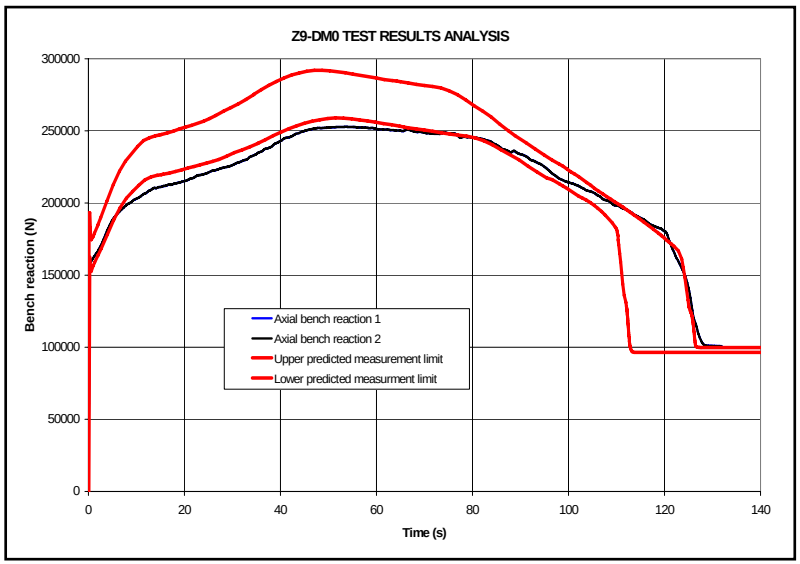
[Requirement Z9 ST-06]

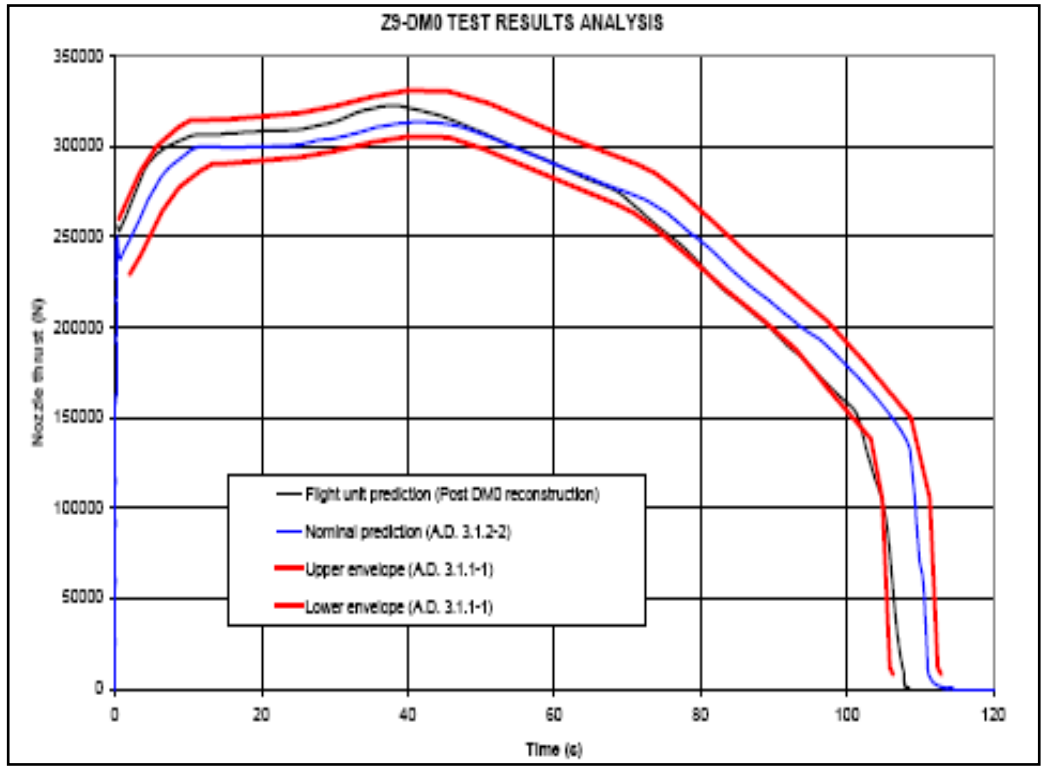
ZEFIRO 9 **SRM OPERATIONAL Phases.**

- First Stage Motor ignition
- LV lift-off
- First Stage propulsive flight
- First Stage burnout detection
- First Stage separation
- Second Stage Motor ignition
- Second Stage propulsive flight
- Second Stage burnout detection
- Second Stage separation
- Third stage coasting
- ZEFIRO 9 SRM Third Stage ignition
- ZEFIRO 9 SRM Third Stage propulsive flight
- ZEFIRO 9 SRM Third Stage burnout detection
- ZEFIRO 9 SRM Third Stage separation
- ZEFIRO 9 SRM Third Stage fall-down and destruction

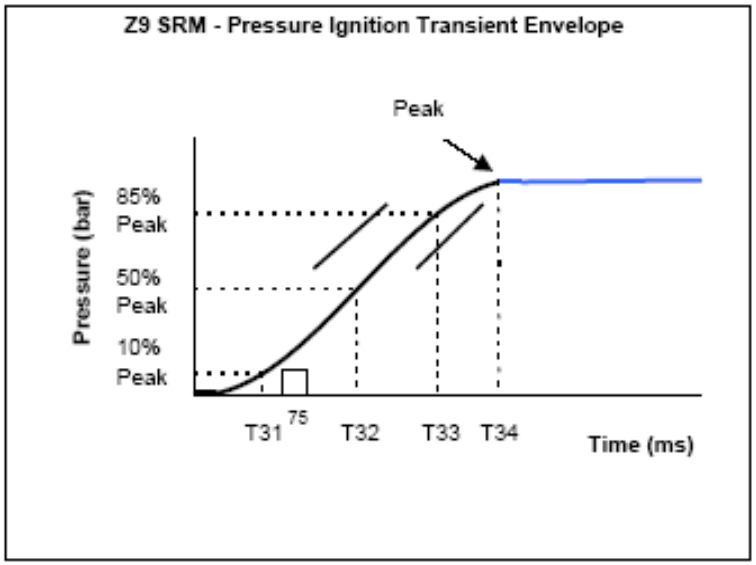
SRMs Requirements: steady state

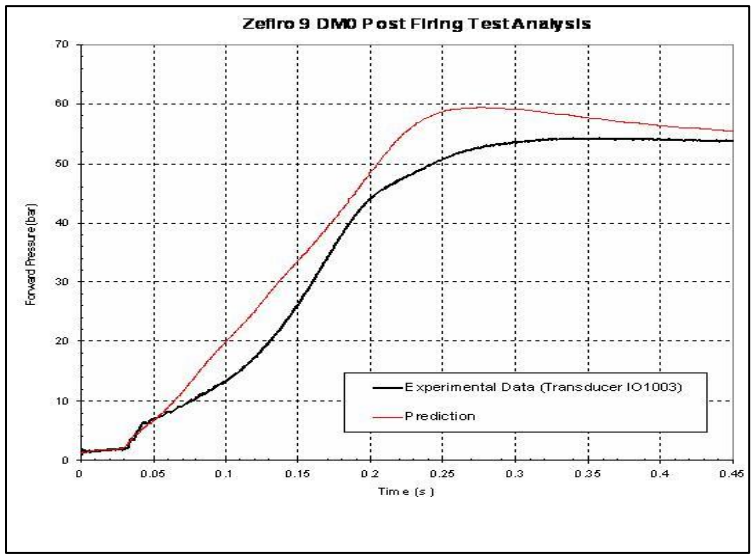


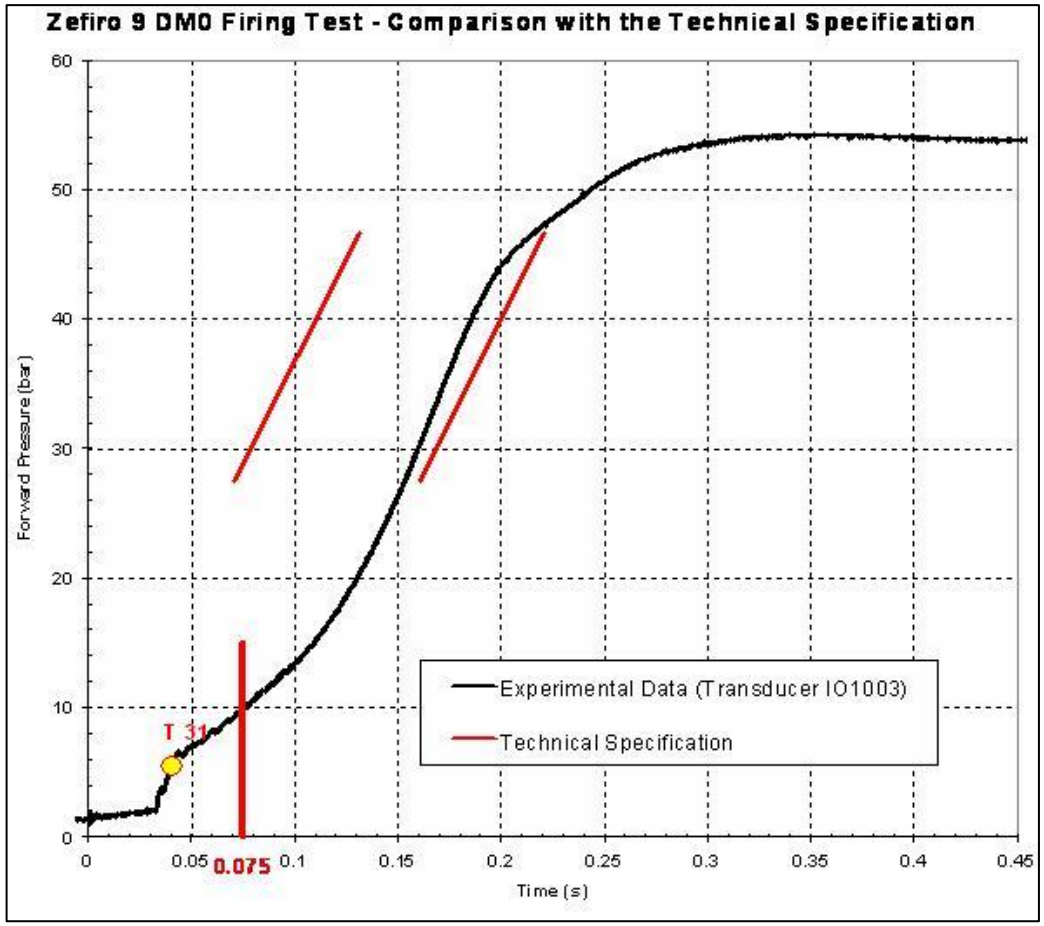




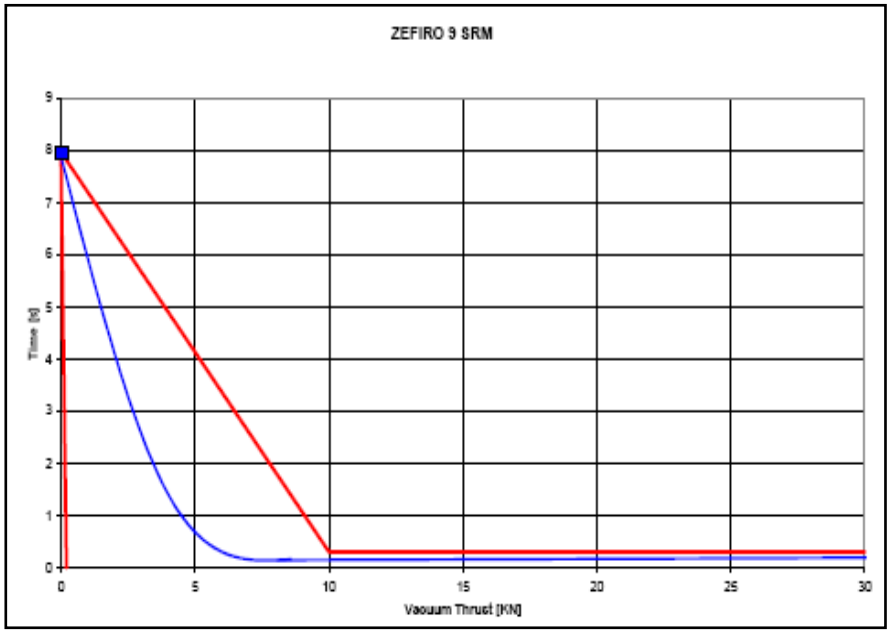
SRMs Requirements: ignition

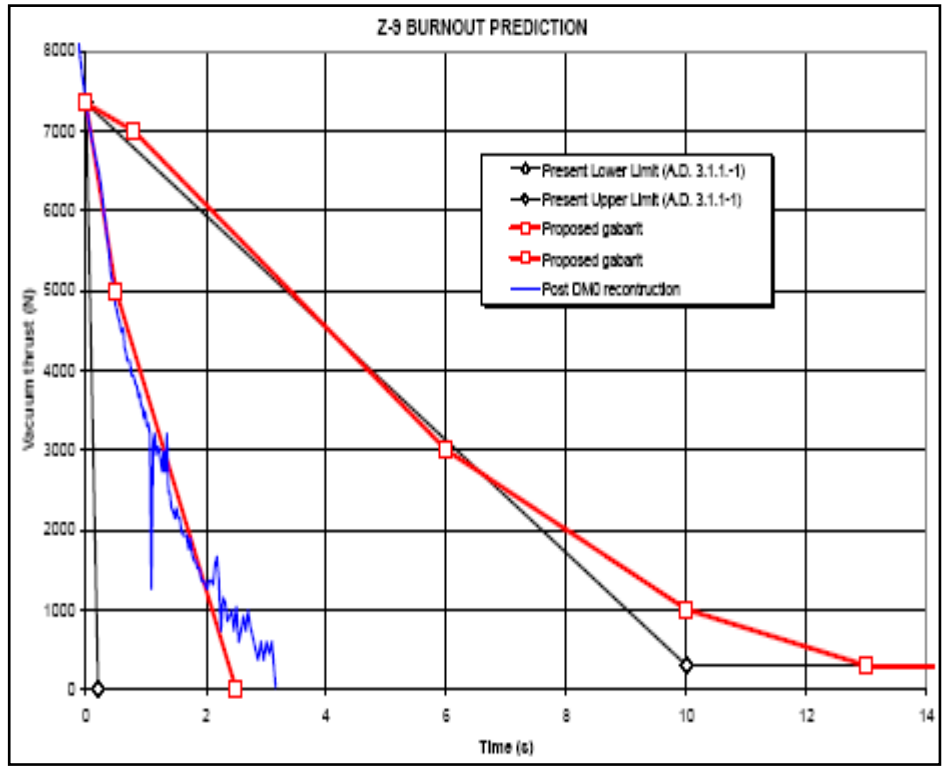






SRMs Requirements: burn out & tail off





Stages Separations

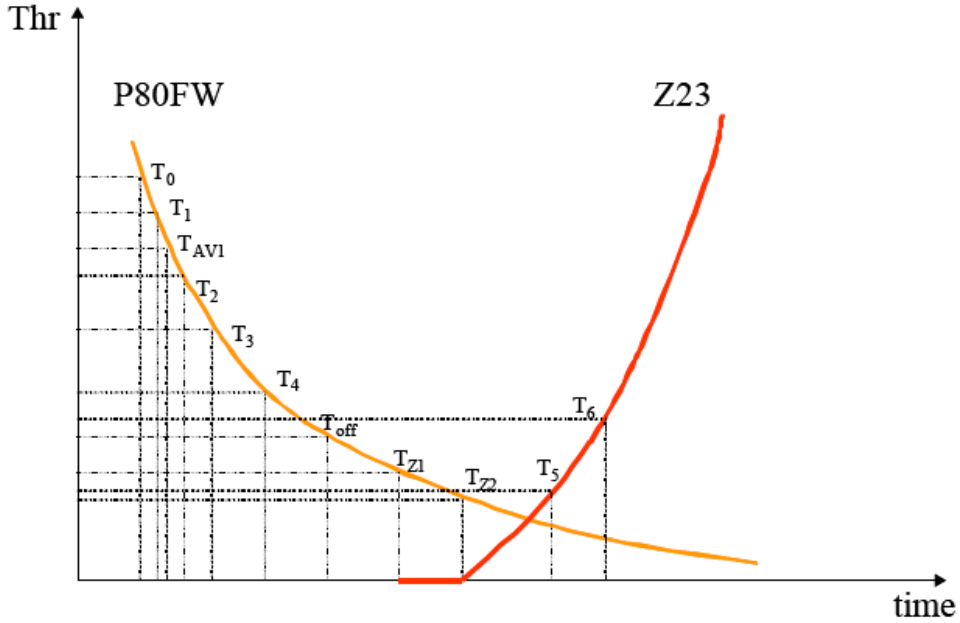


Figure 25 – 1st stage separation timeline

T_0 = FC3	Acceleration threshold detection
T_1	Order for P80 FW nozzle set to last command
T_{AV1}	Order for inhibition of automatic LV destruction and for start the automatic destruction sequence
T_2	Order for Retro Rockets ignition
T_3	Interstage 1-2 pyro-cutting order
T_4	End of Z23 nozzle pulling phase
T_{off}	Order for Z23 nozzle set to off-set angle
T_{Z1}	Order for Z23 ignition
T_{Z2}	Rupture of Z23 nozzle diaphragm (1 m of relative distance)
T_5	Start of Z23 TVC control phase
T_6	Max Z23 TVC deflection

Burn Out & Tail Off Requirements

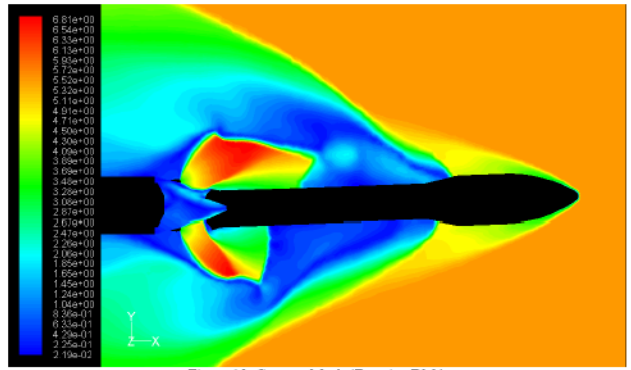
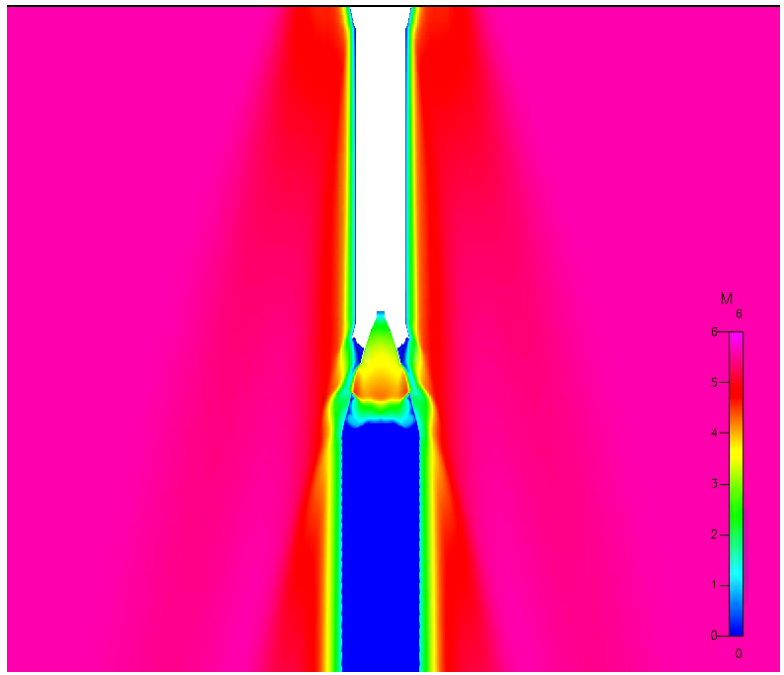


Figura 10: Contour Mach (Zoom) – DMA



SRMs System Requirements

Thrust Envelope